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Was it premature to declare the giant Tongan Ground Skink *Tachygyia microlepis* extinct?

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Dedication. The authors dedicate this paper to George R. Zug, for his friendship, continued support, and his huge contribution to Pacific Island herpetology.

The Tongan Ground Skink, *Tachygyia microlepis* (Duméril & Bibron, 1839), is a large skink endemic to the Tonga Islands in the South Pacific Ocean. It is only known by its two syntypes, which are held in the Paris Natural History Museum (MNHN) as MNHN-RA 2919 and 5493, respectively. The species is listed as extinct in the IUCN Red List of Threatened Species (Pippard 2012, Allison et al. 2022). Although described from a single island located in the southern part of the Kingdom of Tonga (Tongatapu Island), this giant lizard (up to 177 mm in snout–vent length) might still survive on Tongatapu satellite islets or other peripheral larger islands like 'Eua Island. Those islands are less degraded by anthropogenic activities than Tongatapu (261 km^2), which has been heavily impacted by agriculture for nearly 3000 years and now is 90% deforested with only 3.2% of its land area still hosting forest fragments (Wiser et al. 2002) (Fig. 1).

There is a strong morphological resemblance between this Pacific skink and Caribbean-endemic diploglossid lizards, a phylogenetically distant group in which some species possess a habitus that is similar to *T. microlepis*. We conclude that it is possible that they share similar ecological parameters. Here, we suggest to use the scarce information available on these rare convergent diploglossids to extrapolate their habitats to define the biotopes in which this Pacific skink may survive. We also review all available information on this enigmatic large skink.

Tachygyia microlepis was described under the name *Eumeces microlepis* by the two famous French herpetologists, André-Marie-Constant Duméril (1774–1860) and Gabriel Bibron (1805–1848) (1839: 659–662). The species epithet, meaning "small body scales", was selected to point out the large number of small scales around midbody observed in this species (Fig. 2A).

The original description of *Eumeces microlepis* is based on only two specimens (Fig. 2B), which had been collected twelve years before by the physician and naturalist Jean-René-Constant Quoy (1790–1869) and the surgeon-major and naturalist Joseph Paul Gaimard (1796–1858) in Tonga during the circum-global voyage of the corvette 'Astrolabe' (renamed from the former 'Coquille' of Duperrey's travel [11 August 1822 to 24 March 1825]) commanded by Captain Jules-Sébastien-César Dumont d'Urville (1790–1842). It was the latter who had chosen the two scientists for the expedition, both veterans of the Napoleonic navy (Duyker 2014: 171). For his part, Quoy was a gifted draftsman who produced some 6500 drawings during the expedition, and his collaboration with Gaimard during Dumont d'Urville's first two expeditions (1817–1820 and 1826–1829) was so fruitful that it resulted in numerous publications.

This second expedition by Dumont d'Urville began in Toulon on 25 April 1826 and ended in Marseille on 24 February 1829 (Brosse 1998). There is no doubt that the two syntypes of *T. microlepis* were collected during that second expedition for several reasons:

(1) the first expedition never reached Tonga,

(2) the date of the description (1839) predates that of the return of the third expedition (7 September 1837 to 7 November 1840), which also included a visit to Tonga,

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(3) the collectors' names, Quoy and Gaimard, which are attached to these two specimens and to the original description are also clearly indicated as such in the catalogues of the MNHN collections; they can only be referred to this second expedition of Dumont d'Urville and,

(4) the third expedition did not stop over at the island of Tongatapu, but only explored the northern parts of the Kingdom of Tonga (Vava'u Archipelago), whereas the collecting location of Tongatapu Island (as "Tonga-Tabou") appears clearly in both the original description of *T. microlepis* and in the MNHN registers (Fig. 2C).

The Kingdom of Tonga, lying 720 km east-southeast of Suva, Fiji, consists of about 150 islands scattered over some 52,000 km². The islands vary in size from Tongatapu, 261 km², down to mere rocks and reef islets. They form three main groups, which are, from south to north, the Tongatapu Group, the Ha'apai Group, and the Vava'u Group. Additionally, there is the fourth, rather small, outlying group of Niuatoputapu far to the north and the island of Niuafo'ou far to the northwest. Tongatapu, the largest island and the seat of the Tongan government, is about 36 km long and 15 km wide, roughly triangular in outline, with a large lagoon that extends and expands well inland from the north coast. It accounts for more than one third of the total land area of Tonga, which is approximately 700 km². Tongatapu and the other large limestone islands are exceptional in that their surfaces are completely buried under a layer of fine ash 1 to 4.3 m thick, being ancient deposits originating from the volcanoes to the west. The topography of Tongatapu is flat to gently undulating but also somewhat tectonically tilted, rising from sea level in the north to 80 m above along the south coast clifftops. There is some marshland and a zone of mangrove along much of the north coast and around the margins of the lagoon. The climate is moderate, the rainfall variable, rarely extreme and sometimes deficient. Because of the low relief, there is very little orographic rainfall. Hurricanes occur although not frequently. The vegetation of Tongatapu Island today mainly comprises cultivars, mostly pumpkins and squash, or lies in fallow. This island supports at least 60% of the total human population of the Kingdom. That any vegetation even resembles what originally existed there (excepting mangroves) is not surprising, considering that the island has been occupied by humans for 3000 years or even longer (Wiser et al. 2002). Almost the entire island surface is cut up into small family allotments, government lots, and urbanized areas (about 60 towns and villages). Fallow periods have been shortened in response to an increasing population. Other than these fallow plots, little natural vegetation remains except along the coast and in a few protected areas. Even in these, the vegetation has been altered by more than 3000 years of human occupancy. Eleven vegetation types

Figure 1. Aerial view of Tongatapu Island, showing a remnant forest patch and the considerable extent of deforestation for agriculture (mostly squash and pumpkins) in October 1993.

are recognized, and of these, six include the remnants of presumably natural formations, whereas five are secondary or cultivated (Mueller-Dombois & Fosberg 1998).

The anecdotes and reports of the voyage facilitating the collection of the two syntypes of *Tachygyia microlepis* are contained in an impressive series of tomes, published and often penned by Dumont d'Urville himself from 1830 through 1835, the "Voyage de la corvette l'Astrolabe exécuté par commande du roi, pendant les années 1826 – 1827 – 1828 – 1829 sous le commandement de M. J. Dumont d'Urville, Capitaine de vaisseau". A first division includes the travel report of the voyage in five volumes and a historical atlas authored by Dumont d'Urville and published between 1830 and 1833. It also includes a volume authored by François Arago (1786–1853) dealing with meteorology, magnetism, and sea temperature. A second division, written by Pierre-Adolphe Lesson (1805–1888) (brother of René-Primevère Lesson) and the botanist and physician Achille Richard (1794–1852) and published between 1832 and 1834, is devoted to botany and consists of a volume and an atlas. A third division was penned by Quoy and Gaimard and published between 1830 and 1833 and comprises five volumes and an atlas of zoology. A fourth division, written by Jean-Baptiste Alphonse Dechauf-

Figure 2. (A) View of the dorsolateral scale rows of *Tachygyia microlepis*, syntype MNHN-RA 2919; (B) the two syntypes of *T. microlepis* (upper MNHN-RA 2919, lower MNHN-RA 5493); (C) jar tag of syntype MNHN-RA 5493 of *T. microlepis*; (D) aspect of the upper head of MNHN-RA 5493; (E) lateral view of the head of MNHN-RA 5493 showing the left supranasal plate; (F) detailed view of the eye of MNHN-RA 5493 with the scaly eyelid; (G) detail of the ear opening of MNHN-RA 5493.

four de Boisduval (1799–1879), includes two entomological parts devoted to Lepidoptera (1832, 1834). The fifth division, dealing with hydrology and nautical, meteorological and hydrographic observations, was again authored by Dumont d'Urville and published in 1833. Finally, the sixth and last division, in two volumes written by Dumont d'Urville and published in 1833 and 1834, respectively, deals with philology (Duyker 2014).

The volume that interests us here is one of the five containing the itinerary of the voyage of the 'Astrolabe' (1826–1829). This is volume IV, divided into two parts and published in 1832, although only Part 1 concerns the stay in Tonga, while Part 2 details the subsequent visits to Fiji and places farther to the west after leaving Tonga. We report below some information extracted from Volume IV Part 1 (Dumont d'Urville 1832), which we believe is important to better understanding this scientific expedition and its stay in Tonga during the presumed collection of the two syntypes of *Tachygyia microlepis*.

Coming from New Zealand, the 'Astrolabe' arrived in Tonga on 20 April 1827, remaining anchored there for about a month, and eventually departing on 22 May for Fiji. Note that its visit was not an exceptional event for the natives, as indeed, many previous circum-global expeditions had stopped over in Tonga before (e.g., James Cook in October 1773, then again in 1774 and in 1777, La Pérouse in 1787, d'Entrecasteaux in 1793, and many others); Dumont d'Urville (1832) drew up a short summary of those previous visits. Many earlier navigators mentioned intense wars between groups of natives there, although these islands were named Friendly Islands by Cook himself!

Upon its arrival in Tongatapu waters, the 'Astrolabe' hit a coral reef during its anchoring manoeuvres. It remained stranded there for five difficult days before managing to free itself. The 'Astrolabe' then proceeded to and anchored in a safer place on 26 April, two cable lengths from the southern tip of the island of "Pangaï-modou" (now Pangaimotu Island; 18°41' S, 174°00' W), a small satellite island located to the central north of Tongatapu Island, west of another small satellite islet called Manima (21°07' S, 175°09' W), northeast of Nuku'alofa town on the main island of Tongatapu. This same mooring site had been used by Cook and later d'Entrecasteaux during previous expeditions.

Once safely anchored, sailors landed and discovered that "Tonga-Tapu" or "Tonga-Tabou" (Tongatapu Island) was an island with numerous gardens and orchards with generous harvests of fruits and vegetables (e.g., sugar cane, kava, banana, and yams). However, fresh water was rare, but the presence of wells on the satellite islets and a spring in the centre of Pangaimotu Island provided ample of it for the 'Astrolabe'. Dumont d'Urville (1832) noted that the water table was shallow on the main island and that the water was of poor quality. Dumont d'Urville was impressed by the very orderly manner in which the plantations were maintained and far better organized than all those he had observed elsewhere in Polynesia. Pigs were very abundant on the island and easy to obtain from the natives, for example, by means of exchanges or as gifts. Dumont d'Urville (1832) estimated the human population of Tongatapu Island during his visit at 15,000–20,000 inhabitants, which was rather substantial at the time (~67,000 today).

The area closest to the mooring site off Pangaimotu Island was visited regularly by landing parties on rowboat to bring back fresh water. The detailed map of Tongatapu compiled by the tasked sailors shows a main land track made by the Tongatapuans. It connects the village of Hifo, almost at the western tip of the island, to several villages in the centre and the east of Tongatapu Island. Gaimard travelled to the village of Hifo by rowboat via a channel located between Atata islet (21°03' S, 175°15' W) and Toufaka islet (21°40' S, 175°15' W). The majority of the small islets around the anchorage site were visited (e.g., Oneata islet, Manima islet and the largest, Nougou-Nougou islet [now Nukunukumotu islet; 21.15° S, 175.15° W]). The track almost completely crossing Tongatapu Island from east to west was used several times by the two naturalists of the expedition, Quoy and Gaimard. They visited several villages on their way (Hifo, Bea, Moua for example), and also more distant ones, e.g., the village of Oleva. Gaimard repeatedly went to the village of "Moua" (now Mu'a; 21°10'45" S, 175°07'00" W) on the main island of Tongatapu. Villages of particular significance located far from the track, on the shore in the north of the island, such as "Nioukoulafa" (also spelled "Nioukou-Lafa"; now the capital of the Kingdom of Tonga, Nuku'alofa; 21°08'22" S, 175°13'48" W) and "Mafanga" (Ma'ufanga; a sacred site of fortifications housing the graves of many Tongan chiefs), were visited as well, perhaps by rowboat from the anchorage, as were most of the outlying islets north of Tongatapu, such as "Holoa" (now Polo'a islet; 21°06'S , 175°15' W).

In his account of the stay in Tonga, Dumont d'Urville (1832: 86) described the fauna encountered, although he mentioned only a few reptiles. He noted the presence of rats, *Rattus rattus* and *R. norvegicus*, likely introduced by former European visitors (Ineich & Zug 1997). Later in his account (Dumont d'Urville 1832: 336) he indicated that "there are two or three species of serpents, a hydrophis and a small lizard". The snakes probably were the Pacific Tree Boa, *Candoia bibroni* (Duméril & Bibron, 1844), which has a polychromatism that can mislead non-specialists to erroneously identify them as several distinct species. It is not clear if Sea Kraits, *Laticauda colubrina* (Schneider, 1799) and perhaps the rarer *L. laticaudata* (Linnaeus, 1758), were included in what he referred to as 'snakes'. On the other hand, his "hydrophis" may correspond either to *Laticauda* sp. or to *Hydrophis platurus* (Linnaeus, 1766). The first hypothesis seems more probable to us, because *H. platurus* is a pelagic species rarely encountered close to the shores, whereas the two Tongan *Laticauda* species lead an amphibious life. His mention of a single small lizard is quite odd, as Tonga is home to almost twenty species of lizards, almost all of which are widely distributed (Zug 2013)! The account by Dumont d'Urville (1832) also reported very heavy and frequent rains during the stay. These rains could possibly have driven rarer fossorial species out of their flooded burrows and is therefore an important detail to remember.

Louis Auguste de Sainson (1801–1887), the official artist of the expedition, commented on the collections made during the stopover of the expedition in Tongatapu (de Sainson 1831: 15, translated from the original French text): "Not to mention the extreme abundance of provisions that we bought, within a few days the ship was filled with curiosities, shells, and objects of natural history, which the crew procured with unprecedented eagerness. The sailors, who observed the indefatigable zeal of our naturalists, could not be persuaded that their collections had only a purely scientific value. In the belief that a more material interest must be attached to objects so carefully sought, the whole crew applied themselves to bringing together the greatest possible mass of them. These enthused collectors worked with such zeal that, as the voyage was continued, the officers had apply their authority to bring a stop to this scientific collecting fury, and sometimes threw into the sea, to the great disappointment of the collectors, many of the bundles that now really cluttered the ship".

Dumont d'Urville's (1832) account also mentioned a certain member of the crew named Singleton who seemed to be a man actively involved in bringing together scientific and ethnological collections (Dumont d'Urville 1832: 88): "Singleton, who had been absent for a few days, returned today, and brought our zoologists several objects of natural history, particularly snakes and shells of various species, which elicited their full attention". The snakes most certainly represented the Sea Krait *Laticauda colubrina* and/or the boid *Candoia bibroni*. A specimen of the first species from Tongatapu, provided by Quoy and Gaimard is in the Paris herpetological collections (MNHN-RA 7702), and another, without date or collector but with 'Tongatapu' as its locality, probably also originated from this expedition (MNHN-RA 0526). William Singleton was an English landsman who often acted as an interpreter on expeditions (Martin 1817a: 77). He survived a shipwreck in the northern Tonga Islands, and became the official scribe of chiefs of royal rank. Soon after the arrival of the first exploration ships on Tonga, it became fashionable for every high Tongan chief to have a European male as his official scribe. These also introduced the skill of writing to their chiefs, and, because the only available texts were those from the Bible, they introduced the Tongans to the basics of the Christian faith.

Singleton had lived in Tongatapu for 23 years when the 'Astrolabe' arrived, by which time he was married to a Tongan wife and had several children. He mastered the native language, was intimately familiar with the local customs, and his knowledge impressed Dumont d'Urville (Duyker 2014: 218). His help was invaluable to the success of the expedition. He had arrived there on 29 November 1806, when the English corsair 'Port-au-Prince' with 96 men aboard was shipwrecked near the island of Lifuka ("Lefouiga") in the group of the Ha'apai Islands north of Tongatapu Island in the Kingdom of Tonga. The ship had been attacked by the natives commanded by their chief Finau Ulukalala, many crewmen were massacred. However, several sailors survived and settled on the island, including Singleton and a young sailor named William Charles Mariner, then 15 years old. The boy was adopted by the powerful local chief Finau Ulukalala, and the surviving sailors subsequently formed a mercenary artillery force for that chief.

Returning to England in 1817, William Charles Mariner (1791–1853) met John Martin (1789–1869), a London physician who encouraged him to publish his adventures and experiences in this Oceanian archipelago where he had lived completely integrated into the native population. The linguistic and ethnographic knowledge acquired by Mariner in Tonga was considerable. With Mariner most likely being illiterate, he gave an oral account of his adventures to Martin, with precise details, which the latter phrased to form a two-volume book (Martin 1817a, b). It became a historical reference that was published well before Dumont d'Urville reached Tonga, and the latter used it regularly during his stay, just as the Marist Fathers did during their evangelization campaigns. The book relates everyday life and local customs in Tonga during the time of the collection of the two specimens of *Tachygyia microlepis*. It has two sections, with the first concerning the historical evolution of the archipelago during Mariner's stay, and the second being an analysis of Tongan society, its social structures, culture and customs. An appended Tongan word index and grammar list three distinct local names (bíli, mo'co and foky') for three "species" of lizards (Martin 1817a, b), respectively for geckos, skinks, and the *Brachylophus* iguanid.

The nomenclatural history of *Tachygyia microlepis* has been quite dynamic after its description in the genus *Eumeces* Wiegmann, 1834, sequentially passing through the genera *Otosaurus* Gray, 1845, *Liosoma* Fitzinger, 1843 (non *Liosoma* Brandt, 1834), *Lygosoma* Gray, 1827, and *Riopa* Gray, 1839 subgenus *Eugongylus* Fitzinger, 1843. In 1952, Mittleman eventually proposed the monotypic genus *Tachygyia* to accommodate it. This genus is diagnosed by a movable scaly lower eyelid that lacks a more or less transparent or translucent ocular disc, an ear opening being present but its diameter being half or less the diameter of the eye, enlarged supranasals not in median contact, fused frontoparietals, reduced interparietals (Fig. 2D), and very robust and long limbs broadly overlapping when adpressed. Its etymology derives from the Greek word *tachys* meaning "fast" and *gyia*, always used in plural, meaning "articulation of a limb" (such as elbow or knee joint) or just "limb with an articulation". This placement has since been accepted with only one exception. Indeed, on morphological and geographical grounds only, Böhme (1976), following Greer's (1974) hypothesis, considered the Tongan endemic species congeneric with some New Caledonian endemic species (*Phoboscincus* Greer, 1974; two valid species in fact nowadays) to be a member of the genus *Eugongylus*, an early hypothesis that is no longer supported. *Eugongylus haraldmeieri* Böhme, 1976, also currently considered to be extinct (Böhme 2014), is now regarded as the singular member of the New Caledonian endemic genus *Geoscincus* Sadlier, 1987. Subsequently on the basis of molecular data,

Phoboscincus was proved to be a valid genus with no direct Asiatic affinities and a typical member of the endemic New Caledonian eugongyline skink radiation (Ineich et al. 2014; sometimes also included in the lygosomine tribe Eugongylini, see Slavenko et al. 2023) and likely without any direct link to *Tachygyia*. Mittleman (1952), when indicating "Friendly Islands, New Caledonia" in his distribution of the new genus *Tachygyia*, certainly considered *Phoboscincus*, endemic to New Caledonia, to be congeneric with his *Tachygyia*. He, however, did not explain this combination. Later, in his index (p. 24) he regarded *Phoboscincus garnieri* as a species in the genus *Tachygyia*. At that time, *P. bocourti*, the second valid species of the genus *Phoboscincus*, was regarded as a synonym. Subsequently, the idea of linking *Tachygyia* and *Phoboscincus* was revived by Greer (1974) and followed by Böhme (1976).

Tachygyia is a monotypic, endemic genus native to a remote Pacific island (or island group). Its validity must therefore be questioned. Indeed, several similar cases have shown that insular monotypic genera often actually represent local speciose radiations of more widely distributed genera. A major such example is the giant skink endemic to the Cape Verde archipelago, *Chioninia coctei* (Duméril & Bibron, 1839), long considered the only representative of the genus *Macroscincus* Bocage, 1873. Miralles et al. (2010) then demonstrated it to be a giant form derived *in-situ* within the radiation of the endemic speciose genus *Chioninia* Gray, 1845 (formerly *Mabuya* Fitzinger, 1826). Greer (1976) identified this Cape Verde Giant Skink as having the highest number of scale rows around midbody (108–112; 102–110 according to Miralles et al. (2010)), followed by *Tachygyia microlepis* with 65–67). We also note that, as early as 1955 Mertens, followed by Greer (1976), considered *Macroscincus coctei* to be a giant *Mabuya*; this relationship was later verified by a molecular data. Another similar case involving a scincid lizard concerns the extinct Mascarene Giant Skink, *Didosaurus mauritianus* Günther, 1877, which eventually turned out to be a member of the genus *Leiolopisma* Duméril & Bibron, 1839, closest to the type species *Leiolopisma telfairi* Duméril & Bibron, 1839, and placed into the latter genus by Arnold (1980) as *Leiolopisma mauritiana*. There are many more examples of morphologically deviating monotypic genera that are nested within polytypic genera.

But what is the evolutionary history of *Tachygyia microlepis*? The only genus of skinks in this region of the world that has undergone a significant radiation is the genus *Emoia* Gray, 1845, which is not monophyletic (Slavenko et al. 2023). *Tachygyia microlepis* is probably a particularly divergent member of this genus and its affinities should be sought within the radiation of *Emoia* species from the Central Pacific (Samoa, Tonga) with a high number of midbody scale rows. In Walter Brown's monograph on *Emoia* (1991), eight species groups are distinguished that exhibit the following ranges of variation for their midbody scale rows numbers: *Emoia adspersa* group: 48–66; *E. atrocostata* group: 30–43; *E. baudini* group: 26–42; *E. cyanogaster* group: 22–36; *E. cyanura* group: 24–42; *E. physicae* group: 30–44; *E. ponapea* group: 29–33, and *E. samoensis* group: 26–42; but it should be noted that several of Brown's groups have subsequently been demonstrated to be not monophyletic. The *E. adspersa* group possesses the highest number of midbody scale rows, like *T. microlepis*, and this group is native to the same Central Pacific region in which the latter is endemic. The *adspersa* group, as identified by Brown, certainly constitutes a monophyletic lineage, however. Despite the paraphyly of *Emoia* recently demonstrated by Slavenko et al. (2023), the *E. adspersa* group still belongs to the genus *Emoia* sensu stricto. It includes only two very closely related species, *Emoia adspersa* (Steindachner, 1870) whose type locality is in Samoa, and *Emoia lawesii* (Günther, 1874), whose type locality is on nearby Niue Island, south of Samoa and east of Tonga. Thus the *E. adspersa* group occurs only in the Central Pacific, including the extreme north and south of Tonga. *Emoia adspersa* is found in Western Samoa, on the Tokelau Islands, on Pukapuka Island (formerly Danger Islands) in the north of Cook Islands, Funafuti (Tuvalu, formerly Ellis Islands), the French Territory of Wallis and Futuna (Ineich, unpubl. data) and Niuafo'ou Island (15 km²; located in the extreme north of the Tonga Kingdom and only 270 km from Wallis but more than 600 km from Tongatapu). *Emoia lawesii* has a more restricted distribution, including a few islands in American Samoa (Au'nuu, Olosega and Ta'u), on Niue Island and Tongatapu in Tonga (the latter record is based on a specimen in the Natural History Museum in London, BMNH/NHM 90.11.14.4) and thus suggests sympatry with *T. microlepis*. Zug (2013) considered this specimen as a solitary individual that arrived accidentally on the island or as afflicted by a tagging error, because the species has never again been observed on Tongatapu. *Emoia lawesi* is distinguished from *E. adspersa* especially by its larger size (snout–vent length (SVL) 77–106 mm vs. 63–85 mm) and by the absence of a dark brown to black lateral band (Boulenger 1887, Brown 1991), but the fact remains that only a few morphological differences can be discerned. Like other *Emoia*, *Tachygyia* has supranasals (Fig. 2E). In addition to its high number of midbody scale rows, the genus *Tachygyia* is distinguished from all members of the genus *Emoia* by its movable scaly lower eyelid (Fig. 2F) vs. a window in a movable lower eyelid that is typical of *Emoia* spp. However, this is likely not a plesiomorphic character, but an adaptation to burrowing within a lineage of window-eyelid skinks. The developmental modifications for such a change are not great; for example, scaleless individuals occur within wild populations of some snake species (Sayyed & Shinde 2021).

The great resemblance between *Emoia adspersa* and *Tachygyia microlepis* is apparent in the taxon *Eumeces microlepis* proposed by Fischer (1886), a homonym of *Eumeces microlepis* Duméril & Bibron, 1839. The single specimen on which Fischer based his description originated from 'Upolu Island (Western Samoa) and used to be in the Dresden Museum, which was destroyed during the WW II fire-bombing. A transparent window in a movable lower eyelid is indicated in the original description contrary to

the true *T. microlepis* that has a scaly lower eyelid. Boulenger (1887) placed this taxon in the synonymy of *Lygosoma adspersum*, currently *E. adspersa*, and Brown (1991) corroborated this positioning.

Zug (2013) described the coloration of *E. adspersa*. Its dorsal ground colour is a uniform shiny coppery brown to orange-brown, occasionally dark brown; numerous small, dark brown blotches are scattered over the dorsum and sides from neck onto the tail; occasionally there is a dark lateral stripe from the loreal area to the forelimb, and few light spots can be present on the sides of the trunk. Head colour matches the body and is immaculate dorsally; the lips are lighter brown. Venter from chin onto trunk is uniform white or cream to light tan. He also indicated the coloration of the second species of that group, *E. lawesii*. Its dorsal ground colour ranges from tan to dark brown; markings typically appear at midneck and extend onto tail. Lighter backgrounds host some dark brown markings or mottling and often some yellowish white spots; as the background darkens, the dark mottling becomes heavier; limb colour matches that of the body or is slightly lighter. Venter from chin onto tail immaculate creamy white to beige. The colour patterns of the two syntypes of *T. microlepis* are now faded, although we can deduce these from the original description that was based on relatively recently preserved specimens. Duméril & Bibron (1839) indicated (p. 659) sooty brown upper parts, shaded with blackish and also (p. 662) upper parts tawny mixed with brown, or brown mixed with tawny, depending on whether one or the other of these two tints dominates or forms the background of the colour pattern. As for the venter, it is white, washed with reddish. Boulenger (1887) indicated for *T. microlepis* that the upper faces are variegated with brown and rufous, and that the lower faces are reddish white. All these coloration data are relatively similar to each other and match other *Emoia* species that are terrestrial or lower vegetation foragers.

The first person to actively search for *Tachygyia microlepis* was the British John R.H. Gibbons, who with his wife and their two children died tragically in a boating accident on 15 November 1986 while attempting to cross the reef at Lakeba in Fiji. Gibbons was a research professor at the University of the South Pacific in Fiji from 1978 to his death (Anonymous 1986a). He was an active field herpetologist in Fiji, working also in Samoa and Tonga, and described several new species of lizards from the area, including the spectacular *Brachylophus vitiensis* Gibbons, 1981. While visiting Tonga in February of 1986, he offered, through the local press, a reward of 100 Tonga Dollars (about 40 US $) for a photograph or a specimen of *T. microlepis* (Anonymous 1986b; see also Ineich & Zug 1997). This visit was his third and last to Tonga. He called *T. microlepis*, the wanted lizard, "Grey Ghost", in the newspaper and presumed that it lived underground and was active only at night or after very heavy rains.

This giant lizard has also been reported as figuring in Tongan legends. According to one myth, sighting it is an omen of a major family event, such as a wedding or a funeral (Ineich & Zug 1997). Subsequently, several sightings were reported in the 'Tonga Chronicle', but they obviously referred to other *Emoia* species, as was suggested by Ineich & Zug (1997). Indeed, only three of the seven *Emoia* species encountered in Tonga can exceed 10 cm in snout–vent length: *Emoia lawesii* [106 mm], *E. mokolahi* Zug, Ineich, Pregill & Hamilton, 2012 [104 mm], and *E. nigra* (Jacquinot & Guichenot, 1853) [121 mm], with the latter being unlikely to be confused owing to its typical uniform black coloration (Zug 2013). Note however that these sizes are much lower than those of the two syntype specimens, respectively 177 mm in snout–vent length in the larger syntype (MNHN-RA 2919) and 143 mm in the smaller one (MNHN-RA 5493) (Ineich 2009). Despite its large size, *T. microlepis* ranks only 56–57th amongst giant skinks (Greer 2001). In October 1985, just before his third visit (first visit in January 1985), Gibbons and students of Tupou College prospected the last stand of native Tongatapu forest in search of the "Grey Ghost", but without success. Gibbons believed that *T. microlepis* was once abundant on Tongatapu, and that it disappeared as more and more forested habitats were converted into plantations and as a result of the introduction of cats and rats to the island.

Several years later, in October 1993, George Zug and Ivan Ineich in turn visited the only forest patch remaining on the Tongatapu[1] main island, and despite the significant specific richness that had already been outlined by Gibbons (Anonymous 1986b), they did not manage to find *T. microlepis* either. They later published a synopsis of the knowledge on that lizard, based mainly on unpublished information gathered by Gibbons before his tragic death (Ineich & Zug 1997). To our knowledge, no other recent expedition staged searches for this supposedly extinct skink.

Anguimorph lizards of the family Diploglossidae occur in moist, tropical forests of Middle America, South America, and the Caribbean Islands. The recent analyses of Schools & Hedges (2021) and Landestoy et al. (2022), based on new molecular and morphological data, indicated that the widely distributed genera *Celestus* Gray, 1839 and *Diploglossus* Wiegmann, 1834 are paraphyletic. They restricted the former to the Caribbean Islands and the latter to South America and the Caribbean Islands. They also proposed two new genera, *Advenus* Schools & Hedges, 2021, and *Mesoamericanus* Schools & Hedges, 2021, and revalidated *Siderolamprus* Cope, 1861 for the Middle America species. Finally, they assigned the species on the Caribbean Islands, formerly placed in *Celestus*, to the new genera *Caribicus* Schools & Hedges, 2021, *Comptus* Schools & Hedges, 2021, and to *Celestus* sensu stricto, and the revalidated genera *Panolopus* Cope, 1862, *Sauresia* Gray, 1852, and *Wetmorena* Cochran, 1927. Later, they described a new monotypic genus, *Guarocuyus* Landestoy, Schools & Hedges, 2022 for a species from Hispaniola

[1] In south-central Tongatapu, between Tupou College and the airport. This place was used as a religious worship site in pre-European times and is still preserved.

(Dominican Republic). They also described several other new species.

Among these diploglossid lizards, several Jamaican endemic species of *Celestus*, as restricted by Schools & Hedges (2021), exhibit a striking morphological convergence with the skink *Tachygyia microlepis* (Figs 3A–B). This strong convergence includes the overall habitus, particularly the body proportions, limb size and morphology, and head shape. A morphological convergence between the skink *Tachygyia* and diploglossids was previously implicitly noted by Werner (1901) when he created the genus *Macrogongylus* (meaning "large gongylus", i.e., large skink) to accommodate the diploglossid *M. brauni*, now a synonym of the Jamaican endemic *C. occiduus* (Shaw, 1802). Böhme (1976) also considered the skink *T. microlepis* a member of the genus *Eugongylus* Fitzinger, 1843 (meaning "true gongylus"). The gongylus skink-like appearance of *Celestus* was also noted when Wermuth (1969) cited some generic scincid synonyms of *Celestus* sensu lato (included in the Anguidae) that clearly indicate their convergence with skinks: *Euprepis*, *Tiliqua*, and *Scincus* amongst others, including *Scincus gallivasp* Daudin, 1802. Scalation also indicated some degree of convergence as the high number of midbody scale rows varies from 45–50 in *Celestus occiduus* and reach 65–67 in *T. microlepis* (Duméril & Bibron 1839: 662; Böhme & Fischer 1998). *Celestus* occurs almost exclusively in Jamaica, with a single species (*C. macrotus* Thomas & Hedges, 1989) being present on Hispaniola, but this latter taxon does not really match the habitus of *T. microlepis*. Several of the *Celestus* species morphologically convergent with *T. microlepis* are considered extinct, mostly as a result of the introduction of the mongoose.

Eleven species are recognized in the restricted genus *Celestus*, and at last six additional species must be included (Schools & Hedges 2021). Four of them are morphologically convergent with *T. microlepis* (Schwartz 1971; Henderson & Powell 2009; Schools & Hedges 2021). *Celestus hewardi* Gray, 1845 is a Jamaican endemic with a maximal known SVL of 132 mm (Henderson & Powell 2009). *C. macrolepis* Gray, 1845 is a West Indies species that was revalidated by Schools & Hedges (2021) after having been regarded as a synonym of *C. occiduus* and forgotten in the literature for a long period of time. It is a very large species with the holotype measuring 248 mm in SVL. The Natural History Museum London has a second huge specimen (BM RR.1961.1851) with a similar colour pattern that is restricted to the head and anterior parts of the body that was figured by Böhme & Fischer (1998) in a black-and-white photograph (as "*C. occiduus*") and is reproduced here in colour (Fig. 3C). Most likely it is another *C. macrolepis* labelled as *C. occiduus*, and its Jamaican origin was probably simply implied. *Celestus occiduus* (Shaw, 1802) is another Jamaican endemic with an unknown distribution range, but presumably is extinct (last sighted in the 1840s) after the introduction of mongooses. The ZFMK specimen from the historical collection of the Goettingen Museum (ZFMK 26856) was originally mislabelled as an African skink from Fernando Poo (now Bioko) Island ("*Lygosoma fernandi*", now *Lepidothyris fernandi*), and it took some time until one of us became aware of it and recognized that it was not a skink after all, but a diploglossid of the genus *Celestus* (see Böhme & Fischer 1998). *Celestus striatus* Gray, 1839 is most likely a species endemic to Jamaica. Schools & Hedges (2021), who resurrect this taxon gave a SVL of 144.5 mm for the holotype and a comparatively low midbody scale count of 41. These four convergent *Celestus* species all have a terrestrial ecology, living in rocky taluses, stone walls, under piles of garbage, sometimes in swamps; only *C. striatus* is regarded as arboreal. Their dorsal patterns often consist of bars or dark transverse bands, rather than chevrons. They sometimes sport a bicolored pattern, which can be functionally helpful when only the darker anterior part of the body is exposed to early-morning sun-

Figure 3. (A) Holotype of *Celestus striatus* (BMNH 1946.8.8.3), photo courtesy NHMUK and Blair Hedges; (B) Syntype of *Tachygyia microlepis* (MNHN-RA 2919); (C) The Natural History Museum London's huge specimen (BM RR.1961.1851) that was figured by Böhme & Fischer (1998), still identified as *C. occiduus*, is most likely another specimen of *C. macrolepis*.

shine for thermoregulation in a rocky retreat. Staying near the retreat when not fully warmed can improve the protection from predators like snakes and birds of prey.

Searches for fossil records were carried out on the island of Tutuila in American Samoa by Steadman & Pregill (2004). They brought to light several bones, including a maxillary of a skink of the genus *Emoia* whose SVL is estimated at 110 mm (compared to 177 mm of *T. microlepis*). These bone remnants could very well belong to *E. lawesii* whose maximum SVL is very close (106 mm). They are dated to 1,505–1,310 cal B.P. Similar excavations on Niue Island, east of Tonga, revealed gecko fossils but none of skinks (Worthy et al. 1998). We also noted that the Kingdom of Tonga used to be the habitat of a giant iguana of the genus *Brachylophus* Cuvier, 1829, which once existed on the island of Lifuka in the Ha'apai island group located in the centre of the Kingdom during the era of first human colonization. Its fossil bones are dated to stem from the first millennium B.C. and early first millennium A.D. Its size, much larger (nearly double the SVL) than that of current representatives of the genus, was estimated at 371 mm (Pregill & Dye 1989). This large lizard served the island inhabitants as food, leading to its rapid extinction during the first hundred years of human colonization (Pregill & Steadman 2004). Bones similar in size were subsequently collected on Tongatapu Island (Pregill & Steadman 2004), evidencing its occurrence in sympatry with *Tachygyia microlepis*. On the nearby island of 'Eua, Pregill (1993) studied the pre-cultural stratum dated to 60,000 to 80,000 yr B.P. and found two bones (articular and surangular) of a skink whose SVL is estimated at 150–175 mm, undoubtedly attributable to *T. microlepis* (SVL 177 mm) or a closely related form. He even considered the survival of this species: "Conceivably they still exist there. If not, they survived at least up to the time people colonized the island".

We suggest that *Tachygyia* is most likely a member of a local Central Pacific radiation of the genus *Emoia* (*E. adspersa* group sensu Brown 1991), based on geographical, morphological, and ecological data. It certainly evolved in sympatry with *E. lawesii* in southern Tonga (Tongatapu) from which it diverged through character displacement, mostly in the shape of increased body size and scale number, but also acquiring a scaly eyelid, probably evolving in a different alimentary niche and a habitat in which burrowing furthered survival. *Emoia adspersa* and *E. lawesii* are parapatric and nowhere occur in sympatry. It is unlikely that the large size of *T. microlepis* was driven on Tongatapu Island by its sympatry with the large extinct iguanid of the genus *Brachylophus* (Pregill & Dye 1989). Indeed, the diet of these two lizards is totally different (insectivory is probable for *T. microlepis* vs. herbivory for *Brachylophus* sp.), as are their ecologies (terrestrial vs. arboreal). We can hypothesize that on a small island such as Tongatapu (261 km²) the coexistence of two forms of the *E. adspersa* group, with highly similar ecologies, would lead to the differentiation of the species by body size, with one becoming much larger and more fossorial than the other to facilitate their coexistence. Larger size could also give access to distinct food resources. Even if all species of *Emoia* have a window in the movable lower eyelid, the scaly eyelid of *Tachygyia* could be explained as having evolved as an adaptation to a more fossorial lifestyle in a quest to avoid competition on a relatively small island such as Tongatapu. *Emoia adspersa* is likely the most closely related extant relative of *T. microlepis*. We do not think that the scaly eyelid of the later is a plesiomorphic character since the most recent molecular phylogeny clearly positioned *E. adspersa* in a derived lineage (Slavenko et al. 2023). We rather suspect a case of character reversion. *Tachygyia microlepis* has also a reduced ear opening (Fig. 2G), which is another characteristic trait of a burrowing species. Like *T. microlepis*, all species of the *E. adspersa* group have a large number of small body scales. Such scales may function to reduce heat loss from the body surface and may be an adaptation to the cooler climates that are characteristic of many small oceanic islands. We note that the *Mabuya*-like endemic radiation of skinks on the Cape Verde Islands (genus *Chioninia*) only includes species with a high number of midbody scale rows (Greer 1976). The climate of this archipelago is regarded as unusually cool for the Tropics. Perhaps the meteorological situation is similar on the central Pacific islands of Samoa-Tonga?

Tonga's climate is tropical and defined by a wet season from November through April with moderate rainfall, and a dry season from May through October. The wettest months are January, February and March, with precipitation exceeding 250 mm per month. The mean annual temperature in Tonga ranges from 26 to 23°C. During the wet season, average temperatures ranges from 25 to 26°C, whereas during the dry season, averages are 21–24°C. The climate in Tonga and the Central Pacific in general is governed by a number of factors, which include the trade winds and the shifts of the South Pacific Convergence Zone (SPCZ), a zone of high-pressure rainfall that migrates across the Pacific south of the equator. Year-to-year variability in climate is also strongly influenced by the ENSO (El Niño Southern Oscillation) in the southeastern Pacific, which can bring about prolonged drought conditions, and contribute to extreme droughts and the development of tropical cyclones that occur during the wet season. Because both Samoa and Tonga lie between the Tropic of Capricorn and the Equator, their climate is tropical. There is little seasonal or diel temperature variation, although the winters in Tonga, which is farther from the Equator than Samoa, are sometimes relatively cool. There is no pronounced dry season, and all areas except the Ha'apai Islands of northern Tonga receive at least 2000 mm of annual precipitation (Whistler 1992, Chapman et al. 2010). Clearly, southern Tonga, where *Tachygyia* certainly originated, has a climate that is cooler owing to its more removed position from the Equator in the Central Pacific. The southern islands of the Kingdom of Tonga including Tongatapu are among the southernmost Oceanian islands (Tongatapu is located at around latitude 21°S), and this position produces their particular climatic character-

istics, which are colder than on the other islands farther north.

Owing to its likely ecology as deduced from its body shape and coloration, likely niche similarities to those of diploglossids, and its presumed relationships with some *Emoia* species of the *adspersa* group, we conclude that *T. microlepis* is most likely a forest ground-dweller. *Emoia adspersa,* its most likely closest relative, is regarded by both Brown (1991) and Zug (2013) as a coastal species. We do not fully share this point of view. Indeed, one of us (II) carried out intense fieldwork on the Wallis and Futuna Islands and within more than two weeks observed only two specimens of *E. adspersa* (none were collected). It is clearly a very secretive and skittish species. These two specimens were each observed in primary forest several hundred metres from the shore at low altitude (about 100 m), on the ground, amidst small rocky blocks and were quick to hide in a burrow from which they subsequently peeked out only with the anterior body. They never climbed even on the bases of tree trunks. What we want to emphasize here is that it is quite easy to overlook *E. adspersa* for several days in the field, although it is present. We suspect the situation to be quite similar in the case of *T. microlepis*. Greer (1974) was certainly the first to qualify that species as "terrestrial", later labelled "'Tongan Ground Skink". Gibbons (Anonymous 1986b) even suspected this species to live underground and to be nocturnal. We fully agree that it is primarily terrestrial, even if there was no previous explanation for such a qualification. Our data presented above shows that *T. microlepis* certainly is a terrestrial forest species that may also be found in densely vegetated littoral areas where small rocks and perhaps rotting tree stumps provide shelters.

Given the difficulty of observing *E. adspersa* in the field, we conclude that the same may apply to *T. microlepis*. Furthermore, we believe this last species to be unlikely to survive on the ecologically heavily compromised island of Tongatapu (Wiser et al. 2002); however, it may still persist on some peripheral islets (like Kalau islet) or on the large and less ecologically altered island of 'Eua that still retains some primary forest. 'Eua is an ancient, complex island that was recognized as having originated from the Gondwana landmass. It is a small (81 km^2), half-moon-shaped island of about 20 km north to south and 6.5 km across, located 20 km southeast of Tongatapu. Its highest ridges reach 312 m in altitude. 'Eua hosts the most intact primary vegetation of any of the larger islands of Tonga, retaining much of its original forest cover, some of it probably only little modified, tall, primary rain forest (Mueller-Dombois & Fosberg 1998).

The two syntypes of *T. microlepis* were certainly collected following the heavy rains during the Dumont d'Urville expedition, which undoubtedly forced the lizards out of their flooded burrows. Despite the numerous publications dealing with the expedition and the origin of the two syntypes of *T. microlepis*, we found no reference to the collection of two large lizards in all the documents we analyzed and thus we cannot validate that hypothesis. It is unlikely that *T. microlepis* served the first islanders as a source of food as has been suggested by some authors (e.g., Baillie et al. 2010) simply because there is no local name for it, as is common practice for animals used as food like *Brachylophus* and also because the species certainly was rare and secretive even back then. Several authors also speculated that dogs may have potentially been the cause of the skink's extinction (e.g., Doherty et al. 2017), but we think pigs would certainly have posed a greater risk to its eggs.

We believe *T. microlepis* is still alive in southern Tonga and should in particular be searched for in the 'Eua National Park, which hosts the last remaining rain forest of this area (Pagad 2013). It could also occur on the small Kalau Island located south of 'Eua. We agree with Can & D'Cruze (2023) and recommend that decisions about extinctions, as for all conservation-focused initiatives, should be based on the consensus of trained local conservation biologists, local authorities, and locals rather than solely on the opinions of a subjectively selected elite group of experts operating remotely. The premature declaration of a species as extinct is commonly referred to as Romeo's error or the Lazarus effect (Böhme & Stiels 2007). We should not miss an opportunity to save a species. The Dunning–Kruger effect, a phenomenon known in psychology, sets in when people overestimate their competence in social and intellectual domains. As a result, people not only reach erroneous conclusions and make unfortunate choices, their incompetence prevents them from critically evaluating their own thinking. Characteristics of this effect appear to have bedevilled not only the foregoing account, but also instances like prematurely announcing the extinction of other animals such as the Caspian Tiger in Turkey. When reviewing records about the presence of elusive and rare species such as the skink *T. microlepis*, or reading reports about the presence or absence of such species, the reader should think critically about the competence and the field skills of the reporter, and attempt not to be biased by authority or status. Such a situation arrived with the rediscovery of *Phoboscincus bocourti* by one of us (Ineich 2009), a giant skink species considered extinct until it was found again in an area previously largely prospected by numerous professional herpetologists.

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